These unusually severe conditions for May occurred at about the critical period in the development of the fruit buds.

From the foregoing we are inclined to the opinion that the fatal injury to the fruit crop of 1917 in this State occurred either as the result of low temperatures on February 5, 1917, or the cool, wet weather during the period of pollinization in May. Although the temperatures experienced in February (5th and 11th) were not low enough to kill fully dormant peach or apple buds, the effect of the high winds and the unfavorable summer and autumn weather probably more than made up for any lack of sufficient coldness. The damage made by low temperatures appears to be largely owing to evaporation of moisture which can not be replaced while the buds are so cold. We are disposed, however, to attribute a large part, perhaps a major part, of the damage to May weather conditions at the critical period of pollinization.

REFERENCES.

(1) Augustine D. Selby, chief, Department of Botany, Ohio Agricultural Experiment Station, Wooster, Ohio.
(2) Vernon H. Davis, assistant professor of horticulture, Ohio State University, Columbus, Ohio.
(3) W. J. Green, vice director and chief, Department of Horticulture, Ohio Agricultural Experiment Station, Wooster, Ohio.
(4) H. J. Speaker, chief, deputy inspector, Bureau of Horticulture for Ohio, Columbus, Ohio.

COLD AIR PREVENTS SEVERE FREEZE.

By ANDREW M. HAMRICK, Meteorologist.

[Weather Bureau, Grand Junction, Colo., May 5, 1921.]

On the night of April 25–26 the Grand Valley of Colorado experienced a meteorological condition which, though in the nature of a paradox, may well be described under the caption, "Cold air prevents severe freeze."

A cyclone of marked intensity passed over that region on the 23d–24th. The station barometer reading, 24.69 inches, at 8 p. m. of the 23d was the lowest of record at Grand Junction in the last 12 months. Precipitation in the forms of rain and snow amounted to 0.29 inch in the city, which is more than one-third of the normal amount for the entire month. In the outlying fruit districts it was heavier, especially in the vicinity of Palisade, where several inches of moist snow covered the ground and a considerable amount hung on the fruit trees on the morning of the 24th.

During the cold season precipitation seldom occurs in the Grand Valley while the barometer is falling, but just after the turn upward, if the mercury has fallen to 25 inches or lower, precipitation is likely to begin and continue intermittently until it again approaches 25.50 inches. Although not a fixed rule, the precipitation is not continuous for many hours at a time, and the showers or flurries can be associated usually with small but sharp rises in the barometer.

Such conditions prevailed in the Grand Valley from 9:30 p. m. of the 23d until about noon of the 25th. At the latter hour the pressure was 25.33 inches. As the barometer was rising steadily, and local signs and the weather map indicated clearing, with the usual low temperatures caused by radiation on clear nights following storms of that character, grave apprehension concerning the fruit crop in the valley prevailed.

Clearing took place as indicated shortly after sunset, and the sky remained practically clear until about 4 a. m. of the 26th. Radiation was rapid, and the temperature fell from 47° at 6 p. m. of the 25th to 31° at about 4:30 a. m. of the 26th.

The wind was blowing steadily from the east from 1 a. m. until 3:30 a. m., when it switched abruptly to the northwest. In the springtime northwesterly winds carry colder air into the Grand Valley than do winds from any other direction. With the change in wind direction the temperature fall increased rapidly, and it soon passed below freezing.

Since there was a large amount of moisture in the valley, the relative humidity was probably quite high, and the rapidly falling temperature reached the dew point in a short while. Condensation took place in the form of a low stratus cloud, closely resembling a fog, and the latter moved rapidly across the valley from the NW. between the hours of 4 and 4:30 a. m. The cloud checked radiation, and in the process of condensation a considerable amount of latent heat must have been liberated close to the ground further to aid nature in her protective work.

Apples, peaches, and pears were in such an advanced stage of development that it is quite probable the loss would have been heavy had the temperature remained for an hour or more at the low degree reached in some districts before the cloud appeared. In fact, the hygrometric formulæ indicated minima 4° lower, on the average, than those which obtained, and meteorological conditions were ideal for the application of the formulæ, namely, a clear sky with rapid radiation, after the passing of a LOW.

Minimum temperatures at the various substations in the Grand Valley, together with those indicated by the combined hygrometric and maximum-minimum formulæ [1] were as follows:

Stations.	Minimum, 26th.	Indicated.	Difference.
	°	°	°
Clifton	29	27	+2
Fruita	28	23	+5
Fruitvale	29	24	+5
Hunter	28	24	+4
Loma	27	23	+4
Orchard Mesa	29	24	+5
Palisade	30	29	+1
Pomona	28	23	+5
Redlands	30	27	+3
Grand Junction	31	28	+3

On the following night, with practically the same weather indications, the formulæ indicated minima as follows; no cloud overspread the valley during the morning hours, and minimum temperatures were very close to the predicted:

Stations.	Minimum, 27th.	Indicated.	Difference.
	°	°	°
Clifton	28	29	−1
Fruita	25	25	0
Fruitvale	28	25	+3
Hunter	26	25	+1
Loma	24	25	−1
Orchard Mesa	29	26	+3
Palisade	31	31	0
Pomona	26	24	+2
Redlands	27	28	−1
Grand Junction	31	31	0

NOTE.—Weather maps for the two dates were quite similar, but insolation on the 26th gave higher maxima than occurred on the 25th, and the higher maxima when used in the formula indicated slightly higher minima for the 27th.

[1] See MO. WEATHER REV., Suppl. 16, 1919.

At 6 a. m. on the 26th the relative humidity was 90 per cent, the air temperature 32°, and the dew-point 30° on the roof of the Federal building in Grand Junction. Temperatures near the ground usually run 3° or 4° lower.

As it was probable that peaches, in their advanced stage of development, could not withstand dry air temperatures much below 31°, smudges were lighted in the Palisade district, but they were extinguished when the more effective natural heat preserver made its appearance.

The cloud moved in from the NW. and increased in size as it progressed, thus affording protection to all districts.

The thermogram clearly indicates the arrival of the cold NW. wind at 3:30 a. m., and the barogram shows increased pressure just after the aqueous vapor was condensed and its place filled with colder and drier air.

MAPPING THE OCEAN OF AIR.

551.55

By C. E. P. BROOKS.

[Meteorological Office, London, England, Nov. 8, 1920.]

The development of flying, and especially the establishment, actual or proposed, of various commercial flying services, involves an urgent call upon meteorologists to do that service for aviators which they have already done for seamen, namely, to chart the wind currents, in this case not for the surface only but also for the free air. The obvious way of doing this is to study the air movements at different levels directly, by the reports of aviators, by kite and balloon ascents and by studies of cloud motion. It is to the second of these, the kite and balloon ascents carried out at various aerological observatories and on aerological expeditions, that we must at present refer for most of our direct records of air movement in the free air. The most important of the observatories for which the observations have been summarized are those at Lindenberg near Berlin and Blue Hill in Massachusetts, at both of which a large number of observations have now been accumulated and partially tabulated.[1] For Lindenberg the observations are summarized seasonally as percentage frequencies under sixteen directions and five velocity stages, for every half kilometer level from the surface to 4 km.; this is the most valuable as it is also the fullest and most laborious way of presenting the results. The Lindenberg observations have also been employed in several valuable special investigations, such as that by A. Peppler on wind velocity and "veer" in cyclones and anticyclones.[2] The Blue Hill results are given graphically in the form of separate winter and summer wind-roses of frequency and velocity for heights of 650, 1,650, 3,300, 6,600, and 10,000 feet (i. e. surface and approximately ½, 1, 2, and 3 km. above M. S. L.). This volume also contains similar wind-roses for the trade wind region of the Atlantic Ocean, based on observations by Teisserenc de Bort and Lawrence Rotch on board ship [3] and another chart of considerable historic interest, illustrating aerial routes across the Atlantic eastward and westward, for an airship with an engine speed of 25 miles per hour. Observations with kites are now being taken regularly at several stations in North America and published as supplements to the MONTHLY WEATHER REVIEW.[4] J. Rouch [5] gives frequency wind-roses, with indications of force, up to 6 km. at Paris, and at 1 and 2 km. for various points in the western Mediterranean. Unfortunately these diagrams refer only to summer means, and their meaning is not made clear in the text.

The Italian Aerological Service has developed into a very active organization, publishing a *Bollettino Aerologico*, which gives in the form of a daily report tables and charts of the wind up to 5,000 meters obtained by the use of pilot balloons, with other data of interest to aviators. In the last report available, that for December, 1918, 63 stations were in operation, though all these did not send up balloons every day. This form is very useful for day-to-day purposes, but before the data can be utilized for "pilot charts" some form of frequency table or wind-rose is necessary, and it is only at the moment of writing that tabulations in this form have begun to come to hand.[6] Without such summarizing the results are difficult to handle, and to make full use of them they should be tabulated not only under directions, but also under different limits of velocity for each direction, with auxiliary tables showing the normal change of velocity and veer from surface conditions to different heights.

The only other summary of pilot-balloon results on a large scale which has been published is based on observations at Batavia. W. van Bemmelen [7] gives a table showing the resultant direction and velocity of the wind in each month for each kilometer up to 24 km. This form is valuable for theoretical investigations, but for aeronautical purposes is less useful than the detailed frequency form adopted for Lindenberg. It can, however, be employed for finding the best levels to make for when flying in any particular direction.

Mention must also be made of the German aerological expedition to the Indian Ocean and Lake Victoria Nyanza,[8] though the observations have not yet been tabulated into a form suitable for free-air wind-roses.

Of great importance also is the long series of autographic records, commencing in 1890, at the summit of the Eiffel Tower in Paris,[9] at approximately 1,000 feet above the ground, but similar direct observations are not likely to be available elsewhere or at greater heights except on mountains, where there is always the probability of local disturbance of the general conditions.

As regards the observation of cloud movements mention must be made of the researches of Hildebrandsson,[10] but these deal chiefly with the highest cloud levels and have only limited applications to aviation at present. Summaries of the directions of motion of clouds at various levels are made in many climatological discussions; these results, however, have a certain disadvantage compared

[1] For Lindenberg see e. g. Assmann R: *Die Winde in Deutschland*, *Braunschweig*, 1910. For Blue Hill, Rotch: A. Lawrence and Andrew H. Palmer: *Charts of the atmosphere or aeronauts and aviators*, New York, 1911.

[2] Peppler, A.: Windgeschwindigkeiten und- Drehungen in Zyclonen und Antizyclonen, *Beitr. Phys. frei Atmosph.*, Leipzig, 1912, 4, p. 91.

[3] *Travaux scientifiques de l'Observatoire de Météorologie dynamique de Trappes.* Tome 4. Étude de l'atmosphère marine par sondages aériens, Atlantique moyen et région intertropicale. Paris, 1909.

[4] Owing to the extension of aerological work in the Weather Bureau, there has now accumulated a very large mass of observational data, both from kites and pilot balloons, the discussion of which will probably represent the best information on the upper air over the United States. Such a discussion is now in preparation.—EDITOR.

[5] *Préparation météorologique des voyages aériens.* Paris. Masson & Cie, 1920.

[6] Gamba, P. Risultsti dei lanci di palloni-sonde e palloni-piloti effettuati nel R., Osservatorio Geofisico di Pavia nel 1909, . . . 1910, . . . 1911, . . . 1912. Roma *Ann. Uff. centr. meteor. geodin.*, 1911, 33, 176; 1912, 34, 165; 1913, 35, 112; 1914, 36, 156.

[7] The atmospheric circulation above Australasia according to the pilot-balloon observations made at Batavia. Amsterdam, *Proc. K. Akad. Wetensch*, 20, 1919, p. 1313.

[8] Lindenberg, *K. Preuss. Aeronaut. Observatorium.* Bericht über die aerologische Expedition nach Ostafrika im Jahre 1908.

[9] Angot, A.: Etudes sur le climat de la France. Régime des vents. Paris, *Ann. Bur. Centr. Météor.*, 1907, pt. 1, p. 76.

[10] Hildebrandsson, H. H.: *Résultats des recherches empiriques sur les mouvements généraux de l'atmosphère.* Upsala, 1918. (Translation in MO. WEATHER REV., June, 1919, 47:374-389; discussion by W. R. Gregg, ibid, September, 1919, 47:649-650.)